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NCCDS CONFIGURATION MANAGEMENT PROCESS IMPROVEMENT

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SUMMARY

By concentrating on defining and improving specific Configuration Management (CM) functions, processes, procedures, personnel selection/development, and tools, internal and external customers received improved CM services. Job performance within the section increased in both satisfaction and output. Participation in achieving major improvements has led to the delivery of consistent quality CM products as well as significant decreases in every measured CM metrics category.

GETTING STARTED

In early 1989, the Network Control Center Data System (NCCDS) Configuration Management Section was composed of two full-time technical people, one technical person on loan (to be used as required), one task leader, and the section manager. People had been in these positions for two-three years and knew their jobs. The section manager was new to the company, but not to the CM function, the software/engineering field, nor to Total Quality Management (TQM). The main functions of the CM group are to:

- Provide support to formal project reviews, and baseline and control documentation
- Support configuration item identification and discrepancy reporting system activities
- Maintain software product baselines
- Control changes to various software releases at different testing levels
- Provide status, accounting, reporting, and traceability
- Conduct internal audits and support formal project audits
- Coordinate, track, and report Data Management function activities

The challenge was to "coach" the CM group into one which recognized all of the above responsibilities and responded with quality output to the NCCDS community, consistently.

WHAT WAS IT LIKE BEFORE IMPROVEMENT?

In order to fully appreciate the tremendous gains that have taken place in the CM section, a little time must be devoted to understanding where the section needed improvement. The major areas were:

- o Section Characteristics
- o Procedures
- o Tools
- o Communication

Section Characteristics: There were 3.0 staff to support over 100 people project wide, which produced a total of 450k DSI for the NCCDS system. Although the staff was working in the CM functional area, most were only familiar with the product control aspect. There was no CM status, reports, involvement with the Technical Review Board (TRB) or Configuration Review Board (CRB), no documentation reviews, and no emphasis on quality of work at every level. The task leader was the only person with a college degree and the only person who knew most all machine platforms as well as being able to troubleshoot and analyze CM problems. The task leader was the only person who was cross trained and could step in and help out all areas in addition to helping out during crisis situations. The hours for all personnel were long and frustrating, with little praise for good work. CM had the responsibility to support 7 different software segments (CCS, GNSS, ITS, NFE, NTS, RAP, and SPS), on 4 different hardware platforms (VAX, UNISYS 1100, MASSCOMP, and Intel architecture), in 2 facility areas: The Development Test & Training (DT&T) and Operations. The Section Manager, although experienced and knowledgeable of the CM function, was new to the company and new to the NCCDS. Emphasis on training CM personnel or improving CM processes did not seem to be a priority.

Procedures: Of the 7 segments which CM supported , only 4 systems had any written procedures. Three of these procedure sets were poorly written, incomplete, and incorrect in several areas. The other set of procedures were more of a history of the segment, rather than procedures needed to perform routine functions of that segment. There were few clear steps to follow in any sequential order. Because a new software segment was being developed, there were no procedures in that segment. With no staff assigned to that CM segment on a full time basis, there was little emphasis to write CM procedures for that segment. There were many ideas, troubleshooting mechanisms, tips, procedures, and methods written on sheets of paper gathered in notebooks which tended to be lost easily. The procedures that were documented were inconsistently written across segments. This did not support staff cross training. There was also no

one place which housed all CM procedures. Worse, few people used the correct procedures which did exist.

Tools: Simply stated, most tools which were available to the CM group at that time did not work. Custom made tool sets were not maintained thereby causing errors when unknowing staff used them. There was no time scheduled to investigate the root causes and correct problems, just time to fix them. There were many laborious work-arounds that staff used because automated routines were not available or the ability to keep them current did not exist. The inefficiencies resulted in long processing times, incorrect output, and longer fix times. The mere difficulty in using some of the tools themselves caused errors. These internal CM problems were having enormous effects on the rest of the project, in terms of schedule, reliability, cost, causing staff frustration and lowering confidence in the ability of CM to do the job.

Communication: During this time, CM processing time requirements were not recognized on any official project schedules. The time CM required was discussed in management meetings, although internal schedules never reflected the resource. The section manager discussed with the development and test managers the need to "steal" a day on each end of "their" schedules to accommodate CM requirements. This method of acquiring schedule was not conducive to smooth transitions. Most times, the software deliveries were made on the last day of their schedule at 6:00pm and test expected to start the next day at 6:00am. There was no routine status accounting or reporting to the project of CM units processed, reports tracking documentation, or CM efficiency and productivity. In addition, there was little input from CM to the overall project planning process, needs, and problem areas. Participation in CSC Project Management System (PMS) planning, weekly reporting of CM activities to the Assistant Technical Representatives (ATRs), and monthly presentations to GSFC management of CM accomplishments/problems areas was weak.

WHAT WAS DONE?

There were two efforts undertaken to improve the CM function: 1) A management initiative to improve section processes and routine ways of conducting business, and 2) Establishment of process improvements through the participation of CM team members in the Task Oriented Process Improvement Committee (TOPIC).

MANAGEMENT INITIATIVES: After assessing the situation, management devoted emphasis to 1) staffing 2) project participation 3) defining procedures 4) improving tools 5) providing status and reports, and 6) self evaluation of CM processes. Several areas were totally re-engineered.

To remedy the staffing situation, over the next year and a half, there were 8-9 staff personnel hired to work in the CM function. An additional person was on loan, part time, to assist with tools and CM sponsored a summer hire, who helped with the CM data base development. At the end of the CM personnel transition, all personnel had completed their bachelors, 3 people had completed their masters, 3 people were working on their masters, and 1 person was working on a PHd. This higher level of educated personnel was then applied to every segment, which allowed a different degree of work to be performed. In reality, this transition of personnel took nearly 2 years to evolve, and has never stopped. The increased capabilities of the personnel have allowed a much easier cross training of different personnel on different software segments. It reinforced the necessity to have educated and trained personnel and precipitated regular training for CM including internal classes, SEAS courses, vendor classes (both brought into CSC and attendance on vendor sites), and attendance at conferences. The higher level of personnel expertise enabled CM to be able to analyze, troubleshoot, and resolve problems within our own section. People who were doing the work and making errors were able to begin fixing them. This also enabled the group to have insight into what and where some of the root causes of the problems were.

As CM began working more with project management, quality assurance, release leaders, and other technical people, the need for CM to identify processing time on schedules became a reality. Internal schedules contained references to CM time required as well as providing detailed planning schedules prepared by release leaders used to plan Integration, System Test, Acceptance Test, and Operations transitions. CM personnel were able to plan for work and knew what the project deadlines were and where CM fit into the big picture. CM also began to schedule machine/facility resources in the Software Development Facility (SDF), the DT&T, Emergency NCC (ENCC), and Operations areas. By this time the NCCDS had added two facilities; one a development facility in the CSC Greentec I area, and the other an ENCC at the GSFC facility. This added to the CM responsibility of maintaining equal configurations for each release. Having to maintain multiple releases at different test levels sometimes necessitated that CM have their own machine time to perform some processing and installation functions. CM therefore began to schedule resources in the required facilities and "piggy-backed" off other's scheduled time when there was no CM or other function impact.

Procedures were another area which improved dramatically. Personnel have documented or updated all CM procedures. Procedure formats were standardized across all segments in a logical step by step fashion. They were also written to be user friendly, incorporating helpful processing notes. Today the

procedures are used as a training tool for new CM personnel. They are also updated on a routine basis, as a part of the CSC Program Management System (PMS) accountability system. In addition to the documented detailed procedures, an NCCDS CM Software Plan was developed and is revised periodically.

Two major efforts were undertaken to improve CM tools used on the CCS and SPS segments.

1. In 1989 a study was undertaken to determine the best CM tool to use on the VAX. After the investigation was complete a presentation and report was provided to GSFC. The decision was to continue to use the existing CSC written tool which would be enhanced and coupled with Digital Equipment Corporations MMS (Module Management System) tool. Task personnel basically completed the VAX tool effort in 1990. Upgrades have been added each year to continue improving tool productivity and efficiency.

2. Another effort was undertaken in 1990 to improve the Unisys tool. Although there were off-the-shelf tools evaluated, none provided the control, reporting, and speed that were desired. Over a period of one year, task personnel first identified the areas which required immediate attention and made the proper fixes. Second, desired enhancements were identified and gradually added. Both the fixes and enhancements were applied in an internal controlled manner. Internal Problem Reports were written and resolution recommendations were evaluated. Various fixes and enhancements were packaged together and released in builds to the tool. The build was first tested in a testbed on the SDF Unisys. After all bugs had been eliminated, it was inserted into the regular controlled tool which was used in the SDF. Figure 1 contains a high level overview of the SPS tool fixes and enhancements. A summary was presented to the project CRB, approved and then applied to the DT&T controlled version of the tool. These enhancements allowed the tool to run more efficiently and later several utilities were automated into a menu program.

SPS TOOL
FIXES:
O Modified code to work on Unisys 2200 O Modified code to correctly assign level dependent files O Modified code to generate cross-reference tables O Modified code to correctly identified source code type
ENHANCEMENTS:
O Modified code to allocate mass storage efficiently O Developed code to add diagnostic error messages O Developed routines to summarize proccessing results O Developed routines to check entire baseline

Figure 1

The benefits as a result of the tool improvements have been noticeable throughout the section and the project. No longer are incorrect software versions of a unit delivered to test. Listings are routinely run, reviewed, and archived for traceability purposes. These are used later for troubleshooting, if required. The two-three day test sessions have not been hindered by the inability of CM to locate an incorrectly assigned level dependent file. Should there be a problem, listings with diagnostic error messages assist in locating the source of the problem quickly and easily.

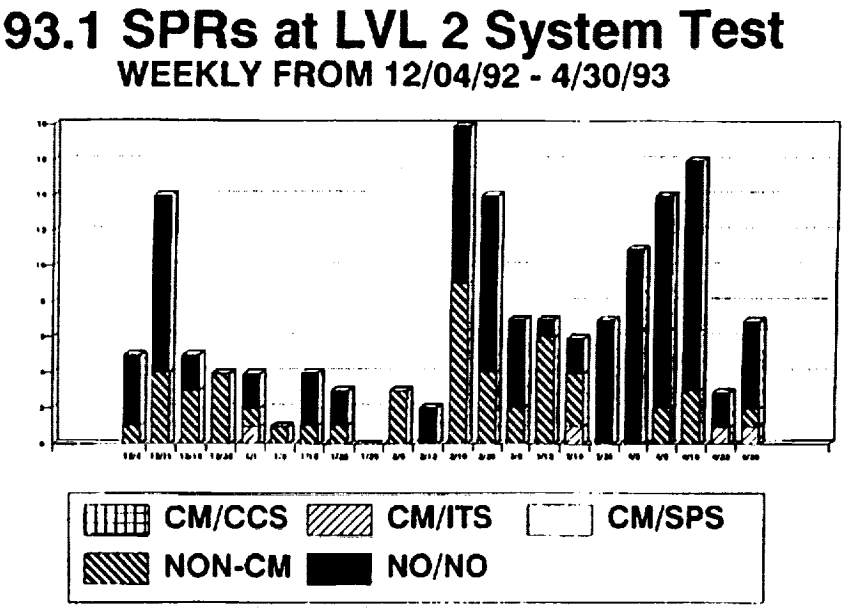


Figure 2

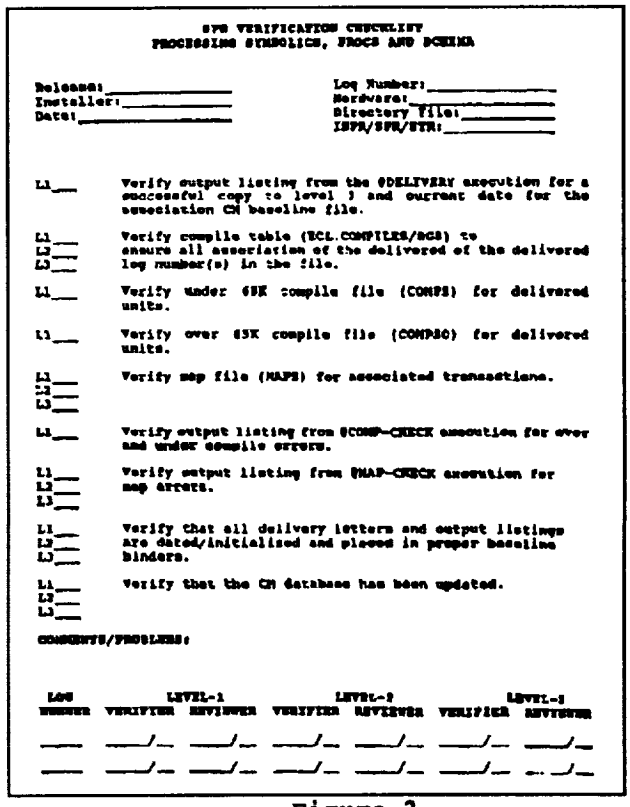
Another tool enhancement to the section was the creation of a CM relational data base to provide traceability, reports, and on line information. Up to this time there was no routine accountability of CM activities to the project. There were no reports or statistics kept within the section. Task personnel developed a data base to house CM data from the Internal Software Delivery Forms (ISDF) and data regarding the CM processing. Data such as segment, subsystem, type of delivery, ISPR/SPR/STR number, unit name, type of unit, date received, and date processed was collected and entered. A units processed report for each release is provided to the project each week. Another report showing elapsed time indicates CM efficiency in processing deliveries from the time of receipt to the time available at any level for testing. Graphs are produced at each project phase for each release and show what (if any) CM problems are occurring on each segment. Figure 2 shows the CM problems by segment for Release 93.1 during the System Test phase. These weekly graphs act as a catalyst for internal CM Defect Causal Analysis (DCA) and in continuing process improvement. This database eventually was merged with the System Engineering Project Database (SEDB) and is known today as the Configuration Management Database (CMDB) and is maintained and has been improved by the System Engineering database section.

CM has code counter tools for each of the NCCDS segments. Over the last two

years, each tool has been upgraded to be more efficient, easier to use, and has been fixed to reduce errors. All of the tool improvements have enabled the CM section to provide products to both internal and external customers faster, better, cheaper, and more accurately.

THE CM TASK ORIENTED PROCESS IMPROVEMENT COMMITTEE (TOPIC): At the same time the above management initiatives were taking place, the CM group began setting aside a small amount of time each week to discuss changes in the section that would improve quality, productivity, worker satisfaction, and reduce errors. In 1990, with CSCs increased interest in Total Quality Management, the group became known as the Task Oriented Process Improvement Committee (TOPIC). The section manager sponsored the group, and every six-eight months the group chose a new facilitator.

The first project the group undertook was to design a set of checklists which were to be used as a verification tool and used in conjunction with the processing procedures. Although the processing procedures were being revised, the group wanted a high level composite list of "musts" that should be accomplished that a second person could verify to ensure the proper steps had been followed. Each segment lead prepared a set of "checks" for each segment and each processing phase. For example, the CCS checklist for processing a delivery includes seven "checks". The verifier completes the checklist as the actual item is checked. The verification is a combination of checking on the terminals and checking the printouts. The checklists can be used for test levels 1, 2, and 3 and are signed and dated by the verifier. An example of an SPS checklist is shown in Figure 3. Other checklists have been designed for phases such as: 1) Creating a Baseline, 2) Processing a Delivery, 3) SDF/DDT Transfer Tape Update, 4) Creating Failover Tapes, 5) Installing a Release, 6) Making Operational Tapes, 7) Processing Symbolics, Procs, Schema, Templates, Maps and QLP Reports, 8) Updating a Baseline, 9) Installing a Release Into OPS, and



SPS VERIFICATION CHECKLIST
PROCESSING SYMBOLICS, PROCS AND SCHEMA

Release:_____ Log Number:_____
Installer:_____ Hardware:_____
Date:_____ Directory File:_____
ISPS/SPS/STR:_____

L1___ Verify output listing from the @DELIVERY execution for a successful copy to level 1 and current date for the association CM baseline file.

L1___ Verify compile table (TCL.COMPILES/SCS) to
L2___ ensure all association of the delivered of the delivered
L3___ log number(s) in the file.

L1___ Verify under SSK compile file (COMPS) for delivered units.

L1___ Verify over SSK compile file (COMPSO) for delivered units.

L1___ Verify map file (MAPS) for associated transactions.
L2___
L3___

L1___ Verify output listing from @COMP-CHECK execution for over and under @compile errors.

L1___ Verify output listing from @MAP-CHECK execution for
L2___ map errors.
L3___

L1___ Verify that all delivery letters and output listings
L2___ are dated/initialized and placed in proper baseline
L3___ binders.

L1___ Verify that the CM database has been updated.
L2___
L3___

COMMENTS/PROBLEMS:

LOG NUMBER	LEVEL-1 VERIFIER	LEVEL-1 REVIEWER	LEVEL-2 VERIFIER	LEVEL-2 REVIEWER	LEVEL-3 VERIFIER	LEVEL-3 REVIEWER
____	____/__	____/__	____/__	____/__	____/__	____/__
____	____/__	____/__	____/__	____/__	____/__	____/__

Figure 3

10) Deleting Units. The checklists are tailored to incorporate segment differences.

Another process established to be used with the checklists, was the incorporation of a reviewer. Usually, the reviewer is either the task leader or the section manager. The review session takes place prior to the delivery or product being installed in the SDF. The processor, verifier, and reviewer go over the delivery from beginning to end to ensure all steps have been completed properly and without error. All printouts, listings, checklists, and original delivery paperwork are reviewed and retained by the CM lead for the segment. Any future inquiries into a delivery, can be recovered and investigated if required. This three-pronged approach has added discipline to the overall process and assisted greatly in the reduction of errors. A partial list of CM TOPIC achievements is shown in Figure 4.

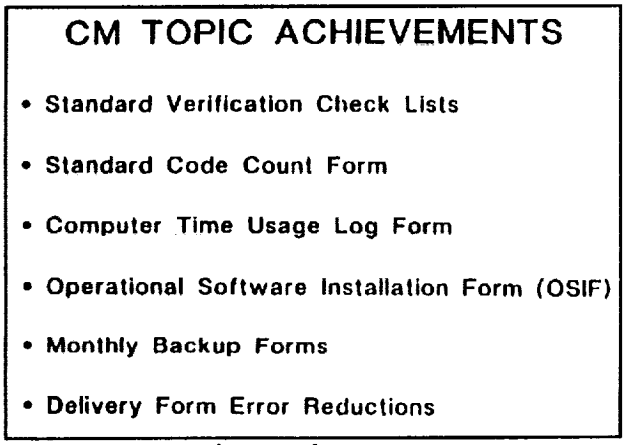


Figure 4

The TOPIC also initiated what they called a "shake down" test. CM processes all the deliveries for a given release for a particular group (i.e Integration Test, System Test, or Acceptance Test) to begin testing. After the installation is made on either the SDF or the DT&T machines, but prior to turnover to the test group, CM coordinates a "shake down" test. This test is a multi discipline team effort comprising the CM segment leads, an integration tester or system tester, a computer operator, maintenance and data base personnel. The CCS, ITS, and SPS segments are brought up, connected, and are checked to ensure all segments "talk" to each other. Although no functions are performed, data passed, or test cases run, this simple check has pinpointed several errors. These problems were cleared up prior to the baseline being provided to the "internal test customer". Time is saved by CM and the testing groups and customer satisfaction is enhanced.

WHAT WAS IT LIKE AFTER IMPROVEMENTS?

Specific: There have been many improvements over the past three years. In addition to the overall management initiatives and TOPIC achievements there have been other individual task improvements. Listed below are only those specific improvements which have been documented through either the CSC Code 550 or 530

cost avoidance system:

IMPROVEMENT	STAFF HOURS-$ SAVINGS/YEAR
1. Revised NTS Build Procedure	- 24 staff hours - 5500 sheets of treated paper per year
2. Improved CM Procedures	- 60 staff hours
3. Simplified Delivery Process	- 32 staff hours
4. Modified CCS Compilation Process	- 150 staff hours - 18 VAX CPU hours in 1991 98 VAX CPU hours in 1992 106 VAX CPU hours in 1993
5. Designed Standard DSI Form	- 114 staff hours - $ 14,022 over 3 years
6. Eliminated Duplicate DSI Counts and Reduced Errors	- $ 5,530 over 3 years
7. Revised and Designed New CM Valtab Procedures and Form	- 26 staff hours

Statistical: Because either little or partial data was maintained in the late 80's in the CM section, the best possible attempt has been made to present fair and accurate data. Emphasis has been placed over the last few years on quality deliveries to our internal customers. Some of those internal customers are Integration and System Test.

During the Integration Testing phase, Integration Software Problem Reports (ISPRs) are written to document problems. Available data show there was a 50% reduction in errors over the three builds after the 89.1 Release series. From Release 90.1 to Release 93.1, CM ISPR errors decreased to around 11%. During the Release 3 Build 0 integration testing, there were zero CM errors out of a total of 51 problems.

CM was accountable for nearly 20% of the project's Software Problem Reports (SPRs), written during System Test phase, up through the 89.1 Release series. Figure 5 shows the SPR trend for earlier releases. During the time many of the

improvements were initiated, Release 90.1 was being developed and CM SPRs fell to about 13%. This trend continued into the development of Release 91.1A, and CM SPRs dropped to under 6%. By the time Release 92.1 was being System Tested, CM SPRs were down to just over 4%.

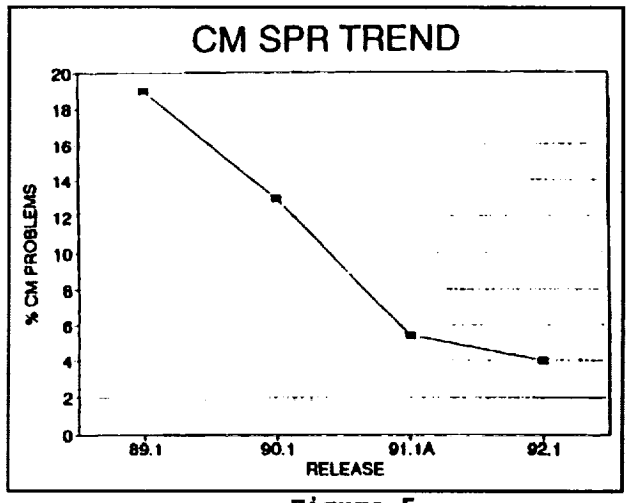


Figure 5

More recently, as shown in Figure 6, the trend has continued to be the same. Release 93.0 found CM SPRs at zero. Release 93.1 was a much larger development effort and CM SPRs were around 2.5%. Release 3 Build 0 is currently under test and to date, CM SPRs are .8%. Clearly, the number of errors attributable to CM has decreased substantially. Obviously, the time spent in correcting problems has decreased accordingly, and a much greater confidence level has been achieved from groups receiving CM products. The project can now count on CM to make internal schedules.

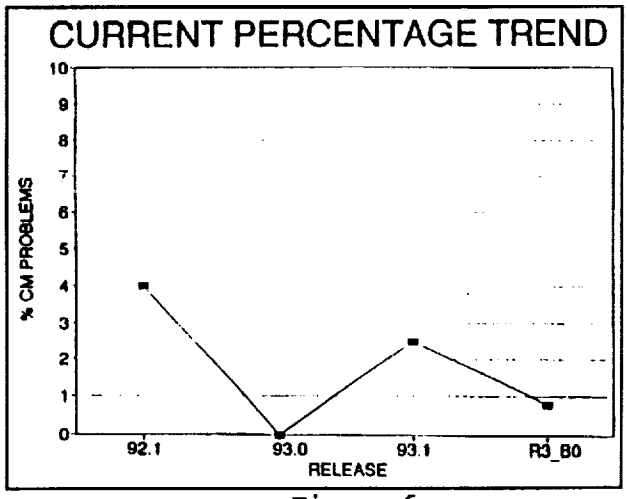


Figure 6

Figure 7 shows a composite of the number of total problems against the number of CM problems.

This improvement has also been seen in installations and products delivered to GSFC. During the Release 89.1 series of deliveries to Acceptance Test, CM accounted for over 13% of the errors identified in the release. Acceptance Test documents problems on a System Trouble Report (STR). Over the next three releases, problems

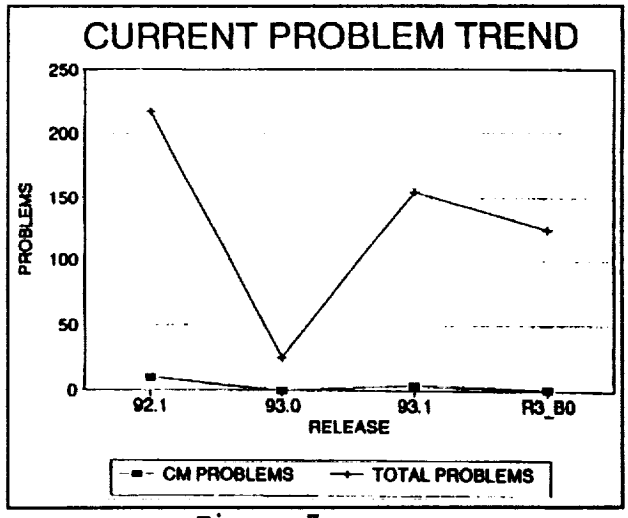


Figure 7

attributable to CM fell to less than 2.5%. There were also no CM STRs for Release 93.0 and only one CM STR for Release 93.1.1, which went operational recently. The turn around in the percentage of CM problems has been dramatic over the past few years. The quality and dependability of CM products and services to our customers has been increased by these measurable results.

Participation: Key to the improvements has been the acceptance of all CM team members to want to make a difference and to make things better. Early in the process, team members recognized the need to become more efficient and more productive. As the opportunity became available to participate in TQM committees all CM section members took advantage. The contributions to the CM TOPIC through the years has been directly responsible for many of the CM successes and improvements. CM has had 100% participation in the five major TQM committees. Two of the five first committees were facilitated by CM members. All CM team members have been involved in Process Improvement Committee (PIC) Process Action Teams (PATs). This participation across project functions to improve a process has provided team members with insight into resolving multi disciplined problems which benefit everyone. The enthusiasm and willingness of CM team members to participate at all levels of TQM activities has strengthened the project, the section, and the individuals involved. Everyone wins.

Recognition: When a job needs to be done, it should not be done to seek recognition. Over time, as each year rendered better results, individuals within the CM group and the team as a whole realized technical and professional recognition. Listed below are some of those achievements:

- Documented and received four Flight Dynamics Quality Improvement Ledgers citing success stories
- Many of the CM achievements have been publicized in the SEAS Total Quality Management Highlights
- Individual CM members and the CM team have received NCC Awards and Recognition Committee (ARC) monthly recognition certificates
- Documented and received three recent cost avoidance success reports
- Two CM team members received FDTG Engineering Employee of the Year Awards
- One CM team member was honored as the first recipient of the NCC Project Dedication, Adaptability, Team Spirit, Unique Solutions and Motivation (DATUM) Award
- One CM team member was a winner of the SEAS TQM Involvement Award

The team was also nominated for the 1992 SEAS Quality Service Award and an individual nominated for the 1993 NTG Quality Service Award. In addition, there

have been letters of commendation from other CSC codes and from the GSFC customer on CM team members excellent service and support.

CONCLUSION

This paper has listed many CM improvements over a wide spectrum and shown meaningful statistical evidence of positive results. The above findings, however, do not mean the group is perfect or that the job is done. The challenge is to provide "continuous" improvements. Because the gap has been tremendously narrowed, future improvements will probably not be measured in whole percentages. The hard job will be to continue to chip away until the goal is obtained. The goal is to have zero processing errors, to provide internal and external customers CM products and services which are error free, and to continue to increase CM efficiency and productivity. "In CM, we don't make the software... we make it better!"